THE TRANSKEI GAP.

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One of the most interesting features of the Transkei, in which territory the Geological Survey has lately been working, is a gap or trough that runs east and west through the country. It is locally known as the Transkei Gap and is produced by a vertical dyke of an easily weathering crystalline rock allied to diorite, which has been intruded into the sedimentary rocks of the district. The sedimentary rocks consist of Karroo Beds lying nearly horizontally; they had already been injected by sheets and dykes of dolerite before this later intrusion took place, so that the newer dyke cuts across both the sedimentary rocks and the dolerite. The Gap is reduplicated in several places, and there is an off-shoot at right angles to the general direction. We have observed the Gap from Toleni Bridge to the place where it runs into the sea at the mouth of the Kogha River, a distance of 50 miles, but we have more or less reliable information that the Gap continues across the Kei into the Colony, as far as parts of the Cathcart Division, which would make the whole length of the dyke to be over 100 miles.

The term "Gap" for a valley of this kind is of local origin and is found on most of the older maps, such as "A Plan of the Territories formerly known as Kaffraria Proper, Cape Town, 1884;" still older maps have a line drawn, showing the course of the Gap, with a note explaining that the Gap "was probably formed by an earthquake." Mr. McKay in the Transactions of this Society for 1884 (Cape Town, 1887) described the Gap and gives the proper explanation of the occurrence, but he did not see that this dyke was peculiar, and had important differences which distinguish it from the ordinary dykes of the neighbourhood.

It is of the first importance to distinguish such a trough, due to the weathering out of a soft dyke, from a "Rift-valley," which produces a somewhat similar type of surface feature. Rift-valleys such as occur in Central Africa, Egypt, the western States of

America, and possibly in the case of the Beagle channel south of Terra del Fuego, are due to the sinking of a long, narrow strip of country between vertical faults; thus, in one recently described in Egypt by Dr. Hume, a narrow slip of cretaceous beds is faulted down between granite cliffs that tower 1,500 feet above them on either side.* In Eastern Sinai, where there is a number of these rifts disposed in two diagonal series, in many of them there is no direct evidence of dislocation, the nature of the valley being inferred from their general appearance; this is the case in several places along the Transkei Gap where the rubble covers the underlying rock; and in such places it might very well be supposed that the valley, walled in by steep cliffs, running counter to the general drainage, might be due to the sinking of a narrow piece between faults; on following up, however, any particular valley, the true cause can always be found in the presence of the coarse crystalline rock in favourable positions. In the case of the Beagle Channel we have not yet any accurate account from which we could assign its origin to a Rift-valley or to a Gap-valley of the type we are describing; but from Darwin's description † of the geology of these parts, which consists essentially of clay-slate, and metamorphic schists with intrusive granite and trap rocks, the Beagle Channel may well be a dyke of crystalline rock which has been eaten into by the waters of the sea and the *débris* washed away. Darwin describes it in the "Voyage of the *Beagle*" as about 120 miles long with an average breadth of 2 miles: "it is throughout the greater part so perfectly straight that the view, bounded on each side by a line of mountains, gradually becomes indistinct in the long distance." This appearance would be produced if the Transkei Gap were to be carried below sea-level, the only difference, apart from its smaller size, being, that in the South African Gap there are usually *débris* slopes on either side; but these of course would be removed if there were a powerful sea running in the channel, and at the same time, owing to the undercutting of the sides, the gap would be widened.

Our definition of the term "Gap-valley," therefore, will be "a long depression between steep walls caused by the weathering of a dyke," a somewhat unusual use of the term Gap, perhaps, yet when seen in the country, the appearance of something missing, as though the earth had "gaped" and opened, which was actually thought to be the case by the older land surveyors, makes the use of the term more appropriate. It is caused by the weathering out of a dyke of diorite which yields more easily than the

* "Rift Valleys of Eastern Sinai," (Abstract) *Geol. Mag.*, May, 1901, p. 198.

† C. Darwin, "Geological Observations," pt. ii. p. 154–156, 1857.

compact horizontal shales and sandstones of the Karroo Series into which it has been intruded; on a small scale, the same phenomenon can be seen on any sea coast where basic dykes are intruded into harder rocks.

Actual mapping of the Transkei Gap was only carried out in the Kentani Division where it runs in an almost direct east and west line for a distance of 36 miles. It enters the division a little north of the N'Debe River where it debouches into the Gcua or Butterworth River; it is here an ordinary dyke of diorite weathering out on the surface of the ground in large boulders, 3 to 6 feet in diameter. It can be followed across the bed of the Gcua, eastwards up a short ravine; on looking eastwards from the low nek at the head of the ravine one sees the typical Gap-valley in which the course of the N'Debe River runs. The top of the cliff above the Gcua and N'Debe is at the general level of the hills and ridges in the neighbourhood and is, in fact, part of the plateau which is the dominant feature of the country. Into this plateau the rivers have cut deep and precipitous-sided valleys winding in and out in a manner one would expect them to do on a fairly level plain, and the original plateau-form is often obscured. These facts show us clearly the course of events which have taken place in the recent geological history of this region. The plateau was a plain of river erosion or a peneplain, near sea-level, and the rivers, having long courses over ground which gave them a very slight fall, wound about on the surface, constantly changing their beds, heaping up banks of sand and gravel at one place, and removing previously deposited material from another. Then the land gradually rose and immediately the rivers began to erode downwards, instead of sideways; the rising of the land has been so continuous that the rivers have not had an opportunity of straightening their courses, but still run in the tortuous channels in which they were running before the land movement took place.

The same elevation has taken place all along the south-east coast of South Africa, from Hang Klip to Natal, but in the west the average elevation of the coastal plain is less than in the country under discussion. The river-gravels were mostly washed away when the land rose and degradation set in with increased intensity; nevertheless, there are always patches, often considerable in the west, which have escaped and remain perched on the top of the ridges; such a patch of river-deposit is to be found on Kentani Hill south of the two Gap-valleys, and owing to its exposed position and the action of water, dissolving the silica of the grains, then depositing it again in the interstices on evaporation, the sandy parts have

become an intensely hard quartzite. Mr. McKay, in the paper above referred to, calls this quartzite a boss of "trachyte," a mistake as to the nature of the rock often made in other parts of the colony, especially when the quartzite forms a level covering to a hill like the sheets of dolerite. At the time when the rivers were meandering across the plain now so deeply cut into, the Gap-valleys were probably not in existence, as the dykes which have since given rise to them would have been denuded no deeper than the surface of the river plain; but when the land rose, and the rivers again began to deepen their channels, certain of the minor streams took the course followed by the dioritic dykes, as these offered the least resistance to the erosive forces of the weather and the streams. The direction of the N'Debe Gap-valley is at first due east, but after a few miles it turns sharply to the east-north-east till it reaches the head of the N'Debe, near Gobogobo trading station. Midway in this diagonal course it is crossed by a branch of the Gap running east-south-east. This branch, which afterwards becomes the principal Gap, dies out on the surface, westwards, before it reaches the Gcua, its upward intrusion having been apparently stopped by a thick sheet of dolerite; nevertheless at the crossing it has cracked the dolerite on the under surface, and thin veins of the dioritic material have been squeezed into the dolerite. The rock at the crossing of the two branches forms a remarkable surface feature, owing to its weathering out in immense blocks as large as the ordinary Kaffir houses. Eastwards of the crossing, we have two Gaps, which soon turn back to a due easterly trend and run parallel, separated by about half a mile of undisturbed Karroo sandstone and shales.

In the following description we shall first follow the northern branch, which is the continuation of the one that was found crossing the Gcua River. It crosses the main road from Butterworth to Kentani, a little north of the trading station of Gobogobo; it is seen on the ridge on which the road lies, in the form of isolated boulders of the peculiar rock imbedded in the soil. On either side of the ridge looking east and west one sees two long depressions, the one on the west being the N'Debe River, that on the east containing a number of streams all endeavouring to assume the prevailing south-east trend, but being forced by the Gap to take, for a certain distance, an easterly or westerly course; each streamlet is separated from the next by a low nek. In this way the Gap reaches the Kobonqaba River, where it apparently stops, no evidence of the rock being found in the river-bed; but to the east we find, not a gap, but a ridge, whose summit runs due east and west and is composed of a particularly micaceous variety of the Gap-rock; this outcrop is only about

three-quarters of a mile long; beyond it to the east there is a typical east and west valley, the head of the N'Kukuwana River, in which, however, no crystalline rock was found. East of this there is no evidence of either a Gap-valley or of any Gap-rock till we come to the Cat's Pass, the reason for this probably being the presence of a thick sheet of dolerite, a northward extension of the great Kologha sheet, which here covers the plateau and has apparently proved an insuperable barrier to the upward rending of the rocks by means of which the Gap-rock ascended. From the Cat's Pass there is a long, sharp ridge, almost a knife-edge, running east and west and bordered on the north and south by deeply-cut ravines. Along this ridge the main road from Butterworth to Manubi forest is carried for a distance of about 4 miles. At the Cat's Pass the diorite is seen on the northern side of the ridge somewhat far down, but it presently, as one goes eastwards, comes on top of the ridge and is practically the cause of the existence of the ridge—that is to say, the hardening that the sedimentary rocks have undergone, owing to the intrusion of the mass of molten rock, has been sufficient to render them more resistant to weathering than the rocks further away from the Gap-rock; the nature of the latter here is in no wise different from that in places where it forms the typical Gap. From the point where the main road to Manubi turns sharply south by Lusizi, the Gap-rock can be followed in isolated outcrops on the level plateau which exists here, each outcrop being linearly east of the last, until we get within 4 miles of the Kogha River. From here there is again a typical Gap-valley thickly wooded on the north side. The whole length of this part of the Gap is occupied by a single straight stream which eventually joins the Kogha, and a corresponding valley is seen on the other side of that river stretching away into the Willowvale Division. In the latter part of the course of this gap the direction is a little north of east. About 2 miles from its junction with the Kogha a long, straight valley is seen trending eastwards in an east-north-east direction; it crosses the Gap, and is seen to be continued over the other side of the Kogha running in a similar direction; no crystalline rock was found in this valley; it has, however, all the appearance of a Gap-valley and may owe its origin to the same cause.

Turning now to the southern branch, a very fine view can be obtained on the Kentani main road a little south of Gobogobo; to the west a succession of steep valleys running in a straight line and separated by low neks are seen, but no crystalline rock can be found in them until one reaches the crossing of the two branches of the dykes. On the east one looks down a long, straight valley, the

N'Gobe, which has a course due east without a twist or turn for 7 miles. A short way from the road, down in the kloof, some great rounded surfaces of the coarse micaceous variety of the Gap-rock occur, but elsewhere, along its course, the river-bed is kept constantly supplied with *débris* from the steep cliffs, so that the underlying rock is not seen. There is a marked difference everywhere between the north and south sides of the river, the northern being covered with forest, while the southern are steep grassy slopes, which the natives, in spite of the difficulty of working, use for planting their mealies and Kaffir corn.

On the other side of the Kobonqaba the Gap-valley is continued to the east; the portion between the Kobonqaba and the Nxaxo Pass being specially characteristic. An enlarged map of this portion is given (Fig. 1) to show the general nature of the valleys in the Gap; elsewhere the valleys approach this type more or less closely,

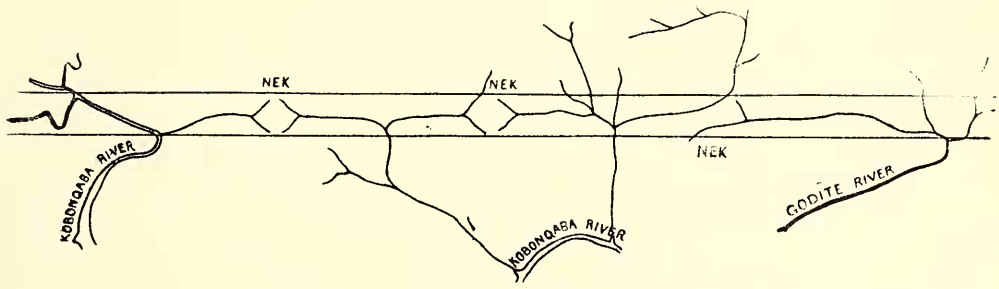

Fig. 1.

Showing the arrangement of the small streams in the Transkei Gap, with the several neks between the valleys. The parallel lines represent the boundaries of the Gap-rock; the country north and south is composed of sedimentary rocks lying nearly horizontal, and injected with dolerite.

but nowhere have we seen the system so neatly developed, or on so small a scale; the valleys here look as if they were artificial trenches with the banks trimmed by the spade. Actual outcrops of the Gap-rock are rare about here, owing to fallen *débris;* but under Nxaxo Pass, on the west, a small block of the diorite was discovered *in situ.* Between Nxaxo Pass and Lusizi Pass the valley is the same. It will be noticed that the Kologha sheet covers the plateau about here and that the south gap pierces it uninterruptedly, thus giving us an interesting comparison of the disruptive forces belonging to the northern and southern dykes.

Looking east from the Manubi main road near Lusizi in the line of the Gap, one has a magnificent view down the Kabakazi River, whose whole length is within the Gap. At the head of the River, however, the foothills of the cliffs overlap too much, and it is only

towards the middle of the Kabakazi that a perfect view is obtained ; standing on one of the foothills in this neighbourhood one can look right down the Gap for some ten miles, the last seven being occupied by the Kogha, and the last four of these containing the tidal estuary of that river. The tidal portion presents in miniature the appearance of the Beagle Channel ; the height of the cliffs is here from 700 to 800 feet ; the northern cliffs are densely wooded and the slope is so steep that each tree stands clear of those below it. The prevailing tints of these forests are dark olive and grey-green, and from the glossy masses of foliage lit up only for a short while in the middle of the day, one hears the hoarse bark of the Lory or the heartrending wails of the baby-bird. At the bottom of the Gap where a small ledge of rock protrudes, dew remains all day long, and the surface is slippery with sodden mosses. On the south side there are few trees, and those mostly Mimosas ; the surface of the ground is covered with thick soil, on which rank long grass thrives.

The walls of the Gap consist principally of Karroo shales and sandstones, but in the southern Gap about Nxaxo these include a thin sheet of dolerite, double in places, which the Gap-rock apparently has not had much difficulty in piercing. East of the Manubi road by Lusizi, however, a thicker sheet comes in, which is probably an independent sheet above the one we have distinguished as the Manubi Sheet. It caps the plateau in isolated patches near the junction of the Kabakazi and the Kogha, and both the northern and southern portions of the Gap have here evidently pierced it. At the actual junction of the Kabakazi with the Kogha, the dolerite is seen rising from the bed of the river as a thick massive sheet, which eventually rises to the level of the plateau, and constitutes the Manubi sheet. At the junction of the Quaninga River with the Kogha, this sheet has already become a capping sheet, the lower walls of the Gap-valley being formed of sandstone and shale. At this place, also, the outcrop of the Manubi sheet turns south-west owing to the plateau being cut away by the coastal streams, and the rest of the course of the Gap-valley to the sea is between walls of sedimentary rocks. The actual mouth of the Kogha is turned south and away from the Gap-valley, the Gap-rock crossing over to the Willowvale side of the river, and running out to sea over a low nek between a small southward promontory and the mainland.

Between Gqunqi and the Kabakazi there is an outcrop of a peculiar rock running in a north and south direction ; it is distinctly more acid than the Gap-rock and might be called a fine-grained granite or a granophyre. There are important differences between it and the Gap-rock, but its occurrence as a straight dyke,

though at right angles to the Gap, shows a similarity in the nature of the crack in which it came to its present position. The outcrop is about 400 yards wide and about a mile long; on either side there are Karroo rocks and included dolerite sheets lying undisturbed, both of which have been pierced by the granophyre. It does not form a valley, but stands up more like a granite boss and the surface is weathered into large boulders. A fine section through the mass is afforded by a deep ravine that cuts through it, but the actual junction of the granite with the other rocks is obscured by *débris*.

The above description can only be regarded as a preliminary note, as there are still several points which further work only can make clear, such as the nature of the western termination, but as it will be some time before the survey can be carried on in those parts, the occurrences seemed of sufficient interest to give the Society a description of it, from the standpoint of our present knowledge.

The rock forming the dykes of the Gap is a peculiar one, differing in important respects from any intrusions hitherto found by us in the Karroo Series, although, as will be pointed out in the following notes, it has a distinct relationship to the olivine-dolerite of the sheets.* It consists chiefly of the following minerals in the order of their usual relative abundance:—plagioclase, hornblende, augite, quartz, red-brown mica, orthoclase, apatite, iron ores, sphene and decomposition products such as chlorite, uralite, and calcite. Variations in the proportions of these minerals show that the rock differs considerably in composition from point to point.

The plagioclase has almost always a zonal structure; the extinction angle of the innermost part of any particular section is in general much higher than that of the outer, which indicates that the inner part of the crystal is of more basic composition than the outer. The plagioclase frequently shows crystal outlines when in contact with the hornblende and augite, sometimes small crystals of the felspar are entirely enclosed by the hornblende and augite. This ophitic structure, though found without difficulty in all the slices of the rock examined, is not nearly so pronounced a feature as in the olivine-dolerite.

The original hornblende is mostly of a pale greenish-brown colour, with feeble plechroism, but a bright green strongly pleochroic variety

* The olivine-dolerite which forms the intrusive sheets of the Transkei is very like the rocks occurring in the same manner near Beaufort West, and described by E. Cohen, *Neu. Jahrb. f. Min.*, 1874, p. 195.

also occurs, sometimes forming part of a crystal which is chiefly made up of the pale kind. Occasionally small crystals showing the prism faces are met with, but the larger plates seen in the slices are always irregularly bounded by contact with other minerals, notably plagioclase. This last remark applies also to the augite, which is colourless in section and appears identical in character with the augite of the olivine-dolerite. The hornblende and augite usually occur together, intergrown with their orthopinacoidal faces parallel. The augite often forms the inner part of a section of the two minerals and is surrounded by a zone of a micropegmatitic intergrowth of the two minerals, outside this area hornblende encases the whole. The structure is easily seen by ordinary light under the microscope, as the augite is colourless and the hornblende pale greenish brown; but between crossed nicols the two minerals are still more clearly distinguished owing to their appearing dark at different positions of the nicols. The intergrowths of the two minerals are sometimes twinned, the twin-plane being the orthopinacoid, common to both minerals.

Hornblende is rarely found in the olivine-dolerites, but it does occur in them; *e.g.*, in the coarse olivine-dolerite of the sheet seen on the shore between the Gxagha and Kologha Rivers, and in the Kologha sheet; in a slice from the dolerite sheet exposed along the Kei River at Mimosa Hill (the Kologha sheet) there is much hornblende of the same variety as that in the Gap-rock, and it is also intergrown with the augite.

The mica is a red strongly pleochroic variety, frequently altered to a very pale greenish mineral with weak double refraction. The mica appears to be uniaxial when examined in convergent light. It is sometimes intergrown with the hornblende, but generally seems to have crystallised later than that mineral. It frequently encloses small zircons, round which there is always a "pleochroic halo"; zircon occurs similarly in the hornblende. This mica occurs frequently, and is an important constituent of the Gap dykes; a precisely similar variety of mica is found in almost all slices of the Transkei olivine-dolerites, but in very small quantity.

Quartz is abundant in some parts of the Gap dykes, and present in all slides examined. It was the latest constituent to crystallise out from the liquid magma; it frequently forms a micropegmatitic intergrowth with a cloudy untwinned felspar, which is probably orthoclase. Both micropegmatite and quartz are occasionally seen in the slices of the dolerites, but they are generally very subordinate constituents of that rock,

The iron ores are magnetite, titaniferous magnetite or ilmenite with

which sphene is very often associated, and iron pyrites. Apatite is always present, sometimes in considerable quantity.

The rock forming the dykes of the Gap may be called a quartz-mica-augite diorite; it differs from the olivine-dolerite very considerably in the absence of olivine, and in the presence of large amounts of hornblende, brown mica and quartz, as well as of the more acid varieties of plagioclase. It is very noticeable, however, that none of the minerals which characterise the Gap-rock are foreign to the olivine dolerites, and in the case of Kologha sheet the dolerite in parts approaches the Gap-rock in character rather closely, by the increase in the amount of hornblende, red mica, and the zoning of the plagioclase. The affinity between the two rocks is sufficient to make it preferable to regard the Gap-rock as derived from the magma which supplied the dolerite intrusions rather than the result of a quite different order of events. If we consider the Gap-rock as a late product of the magma after the dolerite had been got rid of, our view will explain the facts observed under the microscope and in the field, for while the evidence of a microscopic examination shows that the Gap-rock and the dolerite are genetically related, the field evidence conclusively proves that the latter rock had solidified before the former was intruded through it.